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LXV. *Some Account of the extraordinary Agitation of the Waters in Mount's-bay, and other Places, on the 31st of March 1761: In a Letter to the Reverend Dr. Charles Lyttelton, Dean of Exeter, from the Reverend William Borlase, M. A. F. R. S.*

Read Jan. 14,
1762.

ON Tuesday, the 31st of March 1761, about five o'clock in the afternoon, there was a very uncommon motion of the tide in Mount's-bay, Cornwall. The Moon had entered her last quarter on the 28th, at three P. M. so that it was full sea that day, [the 31st] at or about half an hour P. M. and the tide (according to the reckoning of this neighbouring shore) just past the least neap-tide of the last quarter of the Moon. After the tide had ebbed about four hours and half, (for the time is not determined with precision) instead of continuing to retreat gradually, as usual, till it had completed the six hours ebb, on a sudden it advanced as it is usually at the time of the Moon, at an hour and half before high-water. It then retreated nigh to the point of low-water, then it advanced again, and retreated, making five advances, and as many recesses, in the space of one hour; viz. from about five to six o'clock; which was the whole time, that these uncommon stretches of the tide continued. But the first motion was most considerable, the sea advancing the first time to a quarter ebb; but the second advance was
but

but as far as the sea reaches at half ebb. A small sloop of 30 tons burthen, at that time laden and dry in Penzance pier, by the first surge, was floated; by which it appears, that the waters rose at this place six feet perpendicular, that sloop requiring six feet of water to float it.

At the pier of St. Michael's mount, three miles to the east of Penzance, the tide was observed, at the same time, to rise and fall about four feet. At Newlyn, (a mile west of Penzance) the tide rose to the same height nearly, as at Penzance. At Mouthole pier, (three miles S. W. of Penzance) it was only observed, that the sea was in great agitation, and the fishing-boats in danger. At the islands of Scilly, the sea was judged to rise about four feet; but the agitation to have continued longer than in Mount's-bay, viz. more than two hours.

The weather had been fair, and sunshine, with calms, for four days before, in Mount's-bay; but on the evening of the 30th, it was windy; and on the 31st, windy and cloudy, the wind continuing from north to north-east, N. N. E. and east, from the 27th, to the 31st inclusive.

On the coast of Scotland, from Fort Augustus on Lochness, we had accounts, that, on the same 31st of March, about two in the afternoon, Lochness rose, on a sudden, about two feet perpendicularly, and continued alternately rising and falling for the space of three quarters of an hour. The King's galley broke from her moorings, and drove them into the loch; several boats were cast very far upon dry land; in the middle of the loch, the water swelled up like a mountain, extremely muddy, and the motion attended

tended with a very uncommon hollow sound. A perfect calm for several hours before and after (1).

By a subsequent account from the same place, the water is said to have risen near 30 inches, between the hours of twelve and one P.M. and continued for near half an hour. That day, and several before it, remarkably fine. It is added, an instance similar to this happened here, at the time of the Lisbon earthquake (2), viz. of 1755.

Cork in Ire-
land.

On the coast of Ireland, from Cork, there was advice, that, on the same 31st of March, a quarter after noon, a shock of an earthquake was felt in that city, and, between the gates only, allowed to be more violent than that of November 1, 1755. It did not continue above one minute, undulating from east to west, and vice versa (3).

Kinfale.

At Kinfale, about six o'clock P. M. near dead low-water, the tide rose suddenly on the strand, about two feet higher than it was, and went out again, in the space of four minutes, with great force, which repeated several times; but the first was the greatest (4).

Amsterdam.

At Amsterdam, the branches in the synagogue were observed to vibrate, between one and two o'clock. In the great church at Maesland Slys, the branches moved about a foot from the perpendicular, and the vessels in the harbour were agitated (5).

(1) London Chronicle, April 11, p. 350.

(2) Ibid. p. 366.

(3) Ibid. p. 350.

(4) Ibid. p. 358.

(5) Ibid. p. 383.

These are all the traces of this earthquake, which At sea. have yet reached my notice, on the western shores: but it was felt more violently on the ocean, between the coasts of Spain and the British chanel. Ships on their passage from that part of the continent, many leagues to the westward of Cape Finisterre, felt an unusual agitation of the sea, as if they had struck on sunken rocks; the time agreeing with that of Cork and Fort Augustus.

Captain Woodward, of the Expedition packet-Expedition packet. boat, sailed from Lisbon March 29. On the 31st, soon after he had passed the rocks of Lisbon, in the morning, and almost calm, the sea swelled to a great degree, with a rumbling noise. The vessel was tossed about, as if in a storm. The agitation continued four minutes (6).

The Gosport man of war, off the rock of Lisbon, Gosport man of war, and convoy. at three quarters past eleven in the forenoon, felt two violent shocks of an earthquake; the first continued near a minute and half, the second not so long (7). Under the convoy of the Gosport, were several ships, all affected in the same manner. One, off Lisbon, (lat. $44^{\circ} 29''$, long. $11^{\circ} 19'$) felt the shock, attended with a noise, as if empty casks had been tossed about in the hold. The ship immediately made a good many inches of water, which proceeded from the seams opening; the vessel shaking in so dreadful a manner, that, under the apprehensions, that the ship was sinking, the people threw out their boat, and got

(6) London Chronicle, p. 383.

(7) Ibid. p. 386.

all things ready for leaving her, then about 50 leagues from shore.

The Amey
ship of Bristol.

In the latitude 43, not many leagues off shore, in her passage from Lisbon, the Amey of Bristol, Capt. Condon, felt a most violent shock. The concussion was so great, that it shook the needle off the spindle of the compass; and immediately after, arose such a storm of wind and rain, as he never before met with. The shock was felt ten minutes A. M. viz. half an hour before it was felt at Cork, and five hours before the waters rose at Kinsale, and in Mount's-bay, on the same day (8).

Lisbon.

As the thoughts of all persons concerned in observing these phenomena were immediately turned towards Lisbon, distinguished by her unhappy sufferings, when the same agitation of land and water happened on the first of November 1755, every one was in pain for that scarce reviving city; and their apprehensions were not wholly groundless; for there was a violent earthquake at Lisbon, "thought by some as "severe as that of 1755, but the agitation more "equable;" consequently the damages not so deplorable, no lives lost, a few old houses shattered and thrown down, and some new ones cracked; the shock lasted between three and five minutes (9). But more particular is the account following, from an eye-witness, in an English vessel then off Lisbon, i. e. lying before the city. "On March the 31st, at "mid-day, a severe shock, not so strong as that of "1755, but of longer duration. I saw the ruins of

(8) London Chronicle, p. 426.

(9) Ibid. p. 390.

" the last earthquake falling heap upon heap, and,
 " turning round, beheld the rocks on the opposite
 " side falling from the mountains, followed by a
 " continual cry of the people; the buildings erected
 " since 1755 damaged, to the amount of 20,000
 " moldores at least. It lasted about five minutes,
 " some say seven; the water in continual agitation all
 " the afternoon, ebbing and flowing three or four feet
 " in a very short time. At twelve at night, another
 " shock, of short continuance. The next morning,
 " great fogs; that night, three more; did no da-
 " mage. St. Ubes, [ten leagues distance to the
 " south] we hear, has suffered much; and the vil-
 " lages to the north, as also a large convent. During
 " the confusion in the city, 300 prisoners, in the se-
 " veral gaols, gained their liberty; but all except
 " fourteen were secured again (10). The shock felt
 " at Oporto was very strong; but did no damage.
 " At a village about twenty miles distant, three or
 " four houses were thrown down, by which several
 " people were killed (11)."

It is said, that the government of Portugal inter-
 posed; and, to prevent the consequences of terror and
 fancy, (oftentimes as pernicious as realities) prohi-
 bited particular accounts, and even public thank-
 givings.

At Madrid, the violent shock lasted two minutes ^{Madrid}
 and half, shaking the houses, and throwing down
 the furniture; the inhabitants left their houses, for

(10) London Chronicle, p. 376.

(11) Ibid. p. 426.

fear of being buried in the ruins (12). It was remarked here as something extraordinary, that, at the moment it was felt, the atmosphere was quite calm, and a gentle shower fell (13).

Madeira.

At Madeira, the shock was felt very violent, at ten o'clock A. M. It did no damage in the town; some rocks were split, and fell into the sea, and some of the roads of the island suffered (14). Upon the whole, the greatest damage there sustained was the loss of one church, and four people killed, two of which were in a boat fishing near the shore, when the rocks fell (15). Portland man of war in Madeira road.

Barbadoes.

" On the 31st of March, about half past four P. M. near low-water, the sea suddenly retired from the shore, and in about three minutes returned again, to the height of near four feet. This flux and reflux abated about eight o'clock, so as scarce to be perceived; but about ten, it increased again, for some short time, then decreased till six the next morning. The flux and reflux was not always regular, after the three first hours; it was some times performed in three minutes, and at other times in not less than six. On November 1, 1755, the day the earthquake happened at Lisbon, there was then here, in this same manner, an agitation of the water (16)."

(12) London Chronicle, p. 377.

(13) Ibid. May 7.

(14) Ibid. May 9.

(15) Ibid. May 16.

(16) Ibid. p. 578.

We are alarmed with frequent shocks of earth-^{Fyal island,} quakes. The most violent shock we have had of late, ^{one of the} was on the 31st of March last (17). ^{Azores.}

“ On the 31st of March, the sea rose to a great ^{Terceira.} height, and fell again so low, that the quays were left dry; all the lighters and fishing-boats, that were hauled up in Portorico, were carried down into the bay, and broke to pieces upon the rocks (18).”

N. B. About a fortnight after, several earthquakes (successively more and more violent) ended not, till on the 20th three volcanoes threw out as many rivers of lava, of near a mile in breadth, and four yards high, which threatened desolation to the whole country, and continued over-running every tree and house, till the 24th (19).

These, Sir, are all the memorandums I could collect in this place; and it must soon be seen, that they are lame and imperfect, not either sufficiently precise as to time, or so particular as to weather, place, and other circumstances, as might be wished; but, such as they are, (and I doubt not other papers may furnish an additional number to others) I have thrown them into a table, under general heads, with a few deductions, which rose from their comparison.

(17) London Chronicle, July 21—23, 1761.

(18) Ibid. September 1, 1761.

(19) Ibid. p. 214.

SYLLOGE of some circumstances relating to the earthquake felt in the western parts of Europe, and elsewhere, on the 31st of March 1761.

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(1) Mount's-bay in Cornwall.	About five P. M.	About one hour.	Unusual calms and sunshine for five days before; that day cloudy and windy.	The sea rose six feet, advanced five times, and retreated five times.
(2) Scilly islands.	About five P. M.	More than two hours.		Sea rose four feet.
(3) Fort Augustus, Scotland.	By the first account, about two P. M. 2d account betwixt twelve and one P. M.	Three quarters of an hour. Half hour.	That day, and several before it, remarkably fine. A perfect calm for several hours before and after.	By the first account, the waters rose two feet. By the second, the waters rose thirty inches, and in the middle of the loch, swelled like a mountain, with an uncommon hollow sound; the King's galley broke from her moorings; fishing-boats cast far up upon the dry land.
(4) Cork, Ireland.	Quarter past noon.	One minute.		Allowed to be more violent than that of November 1755. The earthquake felt by land only, between the gates of the city, undulating from east to west, and vice versa.

Place.

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(5) Kinfale, Ireland.	About six P. M. ten minutes before five, as per ship Amey.			The sea rose suddenly two feet in height; ebbed and flowed again several times; four minutes retiring, four advancing, with great force; but the first stretch the greatest.
(6) Carrick, <i>ibid.</i>	About four P. M. two hours after flood.			The waters of the river Sure rose four feet in the space of five minutes at Carrick, about thirty miles from the sea, to which the tide, however, reaches. Attested by numbers of eye-witnesses, who reside on the banks of the Sure.
(7) Dungarvon, <i>ibid.</i>	Between four and nine P. M.			The sea flowed and ebbed five times alternately, between four and nine o'clock in the afternoon.
(8) Ros, in the county of Wexford, <i>ibid.</i>	About seven P. M.		The wind calm.	There was a violent commotion in the river, which forced a sloop from its hawlers, and the ferry-boat, on her passage, turned round, with great velocity; the water returned then into its usual course, like a sluice.
(9) Waterford, <i>ibid.</i>				There was an agitation in the river, so that "the sea" rose [i. e. advanced on "the shore] thirty feet " extraordinary, though " it was near the last ebb- " quarter."

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(10) Amsterdam.	Between one and two P. M.			Branches in the synagogue vibrated. Branches in the church at Maesland-Slys moved about one foot from perpendicular. Vessels in the harbour agitated.
(11) On the sea, several leagues to the west of Cape Finisterre.	Quarter past noon.			Felt an unusual agitation of the sea, as if the ship had struck on sunken rocks.
(12) Expedition packet just passed the Rock of Lisbon.	In the morning.	Four minutes.	Almost calm.	The sea swelled to a great degree, with a rumbling noise; the ship was tossed as in a storm.
(13) Gosport man of war off the Rock of Lisbon.	Three quarters past eleven A. M.	About one minute and half.		Felt two violent shocks of an earthquake, and all the ships under this convoy were affected in like manner.
(14) Ship, not named, but with the Gosport, off Lisbon, lat. 44. 29. long. 11. 19.	Three quarters past eleven A. M.			Felt the shock, with a noise, as if empty casks had been tossed about in the hold; the ship shook so dreadfully, that the people, thinking her sinking, threw out the boat, in order to leave her. The ship made some inches of water, by reason of the seams opening.

Place.

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(15) The Amey of Bristol, some leagues off shore from Lisbon, lat. 43.	Three quarters past eleven A. M. Ten minutes A. M.		Immediately after arose such a storm of wind and rain, as he never before met with.	Felt a most violent shock, of which the concussion was so great, that it shook the needle off the spindle of the compass.
(16) Lisbon.	At noon, and at twelve P. M. another shock.	Between three minutes, some say seven minutes. That at midnight of short continuance.	Next morning great fogs.	The shock, thought by some to be as violent as that of 1755, but the agitation more equable." By others reckoned a severe shock, not so strong as that of 1755, but of longer duration. "Ruins of the last earthquake fell heap upon heap; rocks on the opposite side [viz. of the Tagus] fell from the mountains; the water in continual agitation all the afternoon, ebbing and flowing three or four feet [high] in a very short time. Three hundred prisoners escaped out of the gaols of the city; no lives lost; a few old houses shattered, and thrown down; some new ones cracked. Buildings erected since 1755 damaged, to the amount of 20,000 moidores.

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(17) Oporto, Portugal.				Shock felt very strong (without damage); but at a village 20 miles distant, some houses thrown down, and several people killed.
(18) St. Ubes, <i>ibid.</i>				Said to have suffered much.
(19) Madrid.		Two minutes and half.	The atmosphere quite calm, with a gentle shower.	The shock violent, shaking the houses, throwing down the furniture, so that the inhabitants left their houses, for fear of being buried in the ruins.
(20) Madeira.	Ten A. M.			Shock very violent; did no damage in the town; some rocks split, and fell into the sea; in the island, one church destroyed, four people killed, two of which were fishing near the shore when the rocks fell. Some of the roads suffered.
(21) Barbadoes.	Half an hour past four P. M.	Four hours, and, after ceasing two hours, began again, and continued eight hours more.		The sea suddenly retired from the shore, and in about three minutes returned again, to the height of near 4 feet; the flux and reflux not always regular; in the same manner was the agitation of the water on November 1, 1755.

Place.	Time of beginning.	Duration.	Weather and wind.	Degrees of violence, and variety of circumstances.
(22) Fyal, one of the Azores.				Alarmed with frequent shocks of earthquakes : the most violent shock we have had of late was on the 31st of March last.
(23) Ter-seira, ibid.				The sea rose to a great height, and fell again so low, that the quays were left dry ; all the lighters and fishing-boats, that were hauled up in Portorico, were carried down into the bay, and broken to pieces upon the rocks,

COROLLARIES.

1. From these accounts, (supposing them properly authenticated) the violence of this earthquake was greatest at, or rather near Lisbon ; perhaps at sea, in latitude between 43 and 44, and longitude about $11^{\circ} 19'$, where no tremors of land could be observed, and, consequently, the effects not so terrifying, nor perceived by so many, nor so destructive, as if it had happened on the land, and contiguous to Lisbon as that of 1755.

2. It did not begin at Lisbon ; it was felt at Madeira two hours before-noon ; at and near Lisbon about noon ; at Cork in Ireland, a quarter after noon ; but it lasted longer at Lisbon than on any shores in Europe.

3. The weather was different in different places ; at Madrid quite calm, with a gentle shower ; near the

Rock of Lisbon, almost calm; at Lochness in Scotland, a perfect calm several days before and after; in Mount's-bay in Cornwall, for five days before, remarkable calms, but, at the time of the agitation, cloudy and windy: with the Amey of Bristol, some leagues off Lisbon, a most violent storm followed the agitation of the sea.

4. There was a great conformity between the effects of the earthquake of November 1, 1755, and of this of March the 31st, 1761; first, in the extent; 2dly, in the rise of the waters; 3dly, in the calmness of the weather in most parts; 4thly, in the succession of time, beginning sooner at Lisbon than on the northern shores, both times.

Quære. If this conformity (and others, which might easily be traced from the Transactions) so remarkable in different climates, in many places, (and in more it may have passed away unnoticed) could proceed from any thing vague, unsettled, and dissimilar?

Quære. 2dly, If the true cause in both instances was not some explosions in, and eruptions from, the same subterraneous caverns of the earth, caverns circumscribed as before, and branched off nearly in the same direction, the same ducts and grotts communicating the shock of March the 31st, 1761, (as they did before on the first of November 1755) to the waters of the British isles, and some islands in America, but not with equal force, nor diffusing their tremors so universally to land, sea, lake, and pond, the inflammable materials being either not equal in quantity, or not equally combustible or explosive?

5. As it was calm in most places, it was succeeded by a violent storm in latit. 43, at sea.

Quære. Whether this storm did not put an end to the earthquake, in the spot and neighbourhood of its greatest momentum, the extraordinary vent, or breaking forth of the imprisoned vapours, leaving the shaken parts of the earth's shell quickly to settle, and return to its wonted stability?

6. At Cork in Ireland, (if those accounts may be depended on) there are two particulars remarkable; that shock was felt almost at the same time of the day as at Lisbon. 2dly, That it was felt only at land, not apparent in the sea: at Lochness, Mount's-bay, and Kinfale, it was visible in the waters only, without affecting the land; at and near Lisbon, forcibly agitating both land and water.

7. Quære. Whether it is not apparent, from these similar effects, at such distant times, and in places so remote from each other, that the shell of the earth is cavernous, abounding more or less, and interspersed with oblate, compressed hollows; (which may be called the pores of our terraqueous globe, and spread from different points, (or centers) like the roots of trees from their trunks; and whether the caves and subterraneous passages, being in some parts narrow, little, more crooked, or otherwise impeded by accidental obstructions, or more remote from the first and chief momentum, may not be the reason, why the surface in some places is little or not at all affected, and the shock later in time; but where the passages are straight and open, and near the first and strongest explosion, there the shock is earlier, and the agitation proportionably more violent?